## Future Improvements

The design of RHIC which is described in this document is believed to be conservative and does not preclude luminosity improvements in the future. A period of operation, during which basic experimental information about the machine parameters is acquired, should clarify how to improve the integrated luminosity, for example. However, even now there are some ideas which show, in a general way, how improvements might be made. Improvements beyond the design luminosity by about an order of magnitude for both heavy ion and proton beams are considered possible.

Our design is based on a current of 200 µA from the Tandem. Ion source experts feel that it may be possible to produce as much as 400 µA of heavy ions. Currents in excess of 500 µA have already been demonstrated for ions such as $^{12}C$. Even with the present 200 µA source at the Tandem, it seems there is a possibility for an increase by a factor two of the total number of ions that can be stored in one bunch for RHIC. This would then yield an increase of a factor four in the luminosity.

The luminosity can also be increased by increasing the number of bunches in the ring from 60 to 72, 90 or 120. The day-one design objective calls for 360 rf buckets at injection per ring of which only every 6th one, for a total of 60, will be carrying a bunch. This choice permits a maximum injection kicker rise time of about 190 nsec, about the length of five buckets or rf periods. If the rise time is made sufficiently shorter, more buckets could be filled. Doubling the number of bunches imposes a maximum kicker rise time of 95 nsec allowable for filling every 3rd bucket thereby doubling the luminosity. Note that intrabeam scattering is unaffected by this procedure. However, the average beam current would be doubled and so would the total energy stored in the beam. The filling time would also increase linearly with the total number of bunches. It is the intention to install on day-one an injection kicker with 95 nsec rise time but limit the number of stored bunches to 60 in view of constraints due to the beam dump and AGS operation requirements. However, the rf system will be designed to accommodate 120 bunches with twice the design number of ions per bunch in order to avoid costly future replacements.

Another possibility to improve luminosity exists by further reducing â* through the addition of quadrupoles for a mini-beta configuration at the expense of leaving only about ±5 m free space for detectors.

The design of RHIC makes use of two rf systems, one for acceleration at the harmonic number *h*=360, and the other at much larger frequency (197 MHz) to keep the bunches with a short and almost constant length during the storage. One scenario to achieve design luminosity has been developed where, in order to save cost, the maximum available rf voltage in storage mode is limited to 6 MV. Subsequently, based on the experience acquired with the operation of the collider, more rf cavities, possibly superconducting, can be added for a maximum voltage of 16 MV which is required to miminize beam loss in the case of Au ion beams.

During the last decade stochastic cooling has been developed into a practical means for reducing beam emittances and momentum spreads without loss of particles. Used in RHIC its function would be to control the emittance and momentum spread growth so as to keep the beam dimensions well within the magnet aperture and the bucket height and to lengthen the luminosity lifetime. One expects that a stationary and stable equilibrium density will develop when the growth rate due to intrabeam scattering just matches the damping rate due to cooling. Estimates of the achievable damping rates for momentum cooling have been made assuming a 4 to 8 GHz bandwidth. The use of momentum cooling in the framework of the 6 MV storage rf would reduce beam loss resulting in a luminosity gain by a factor 2 at top energy. Further luminosity gains would require the addition of transverse cooling.